A Memorandum

on

O L I O M Y E L I T I S

By

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and

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"Together we will conquer poliomyelitis. Together we will advance into a new era of humanitarian endeavour, and mankind will ascend to the heights of true civilisation under the leadership of men of science, men of faith and men of peace".

Basil O'Connor
(From an address to the Second International Poliomyelitis Conference, 1951)

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A MEMORANDUM ON POLIOMYELITIS

1. Introduction

1.1. The history of poliomyelitis provides a striking illustration of the need for a continually evolving approach to the study of disease problems. During the past century or so, the epidemiological behaviour of poliomyelitis has changed considerably and so also our ideas. What was originally a relatively uncommon disease occurring sporadically, it has now evolved itself into an epidemic disease of varying degrees of severity presenting a major public health problem in many countries. In these countries what was predominantly a disease of infants - hence the name infantile paralysis - it is now showing a tendency to affect subjects of increasingly higher age. Further, epidemic poliomyelitis is no longer confined to countries with a temperate climate but is being reported with increasing frequency from tropical countries as well.

1.2. India was remarkably free from epidemics of poliomyelitis for a long time. Until very recently, poliomyelitis was an endemic disease in the country mainly affecting children in the lower age groups and occurring in a sporadic form. The presence of the disease in the community was often brought to light by an occasional case which came to the notice of orthopaedic surgeons for deformity and disability consequent upon paralytic poliomyelitis. This situation changed, however, in 1947, when one of the most severe epidemics of poliomyelitis struck the population of Car Nicobar in the Andaman group of islands of the Indian Union. Two years later, i.e. in 1949, poliomyelitis broke out in an epidemic form in and around the city of Bombay. This epidemic received wide publicity in the popular press and served to stimulate the interest of the public in the problem of poliomyelitis generally. Poliomyelitis had not received till then any attention at the hands of medical research workers in the country and data on some of the essential aspects of the disease were practically non-existant. One did not know what were the virus strains responsible for poliomyelitis in the country and what were the factors involved in its spread in the community. Answers to these and other questions will and must form the basis of any control programme against poliomyelitis. Realising the need for some of these base line data on poliomyelitis, the Indian Council of Medical Research had created about five years ago a Research Unit for the study of poliomyelitis in the Pathology School of the Grant Medical College, Bombay. The Unit is still functioning and has already contributed materially to the advancement of our knowledge about the disease in this country.

1.3. The recent announcement of the development of an effective vaccine against poliomyelitis by Salk in the U.S.A. has aroused further interest in the poliomyelitis problem as it affects India. Everywhere the question is being asked as to whether such a vaccine

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could be used in India. It should be remembered, however, that the Salk vaccine is not an isolated event but a culmination of a long series of advances made by numerous workers in this field. It was, therefore, considered desirable at this stage not only to review the importance of poliomyelitis as a public health problem in India but also to draw the attention of the public health administrator to the recent discoveries and present thinking on this subject in so far as they relate to the attainment of the ultimate goal, namely, the eradication of poliomyelitis. The present memorandum attempts to do this. It is neither comprehensive nor detailed since many aspects of the disease, such as treatment, are not referred to at all. It only refers to those aspects of the disease, which we venture to hope, may be helpful to medical and public health administrator in developing a proper attitude to the poliomyelitis problem in this country in the context of recent developments.

2. Clinical Features and Pathology of Poliomyelitis

2.1. Clinical:

The clinical features of poliomyelitis in India have been described by Vora and Coelho and are similar to those met with in other parts of the world. For this reason, only a brief description of clinical features is given here, the object being to refer to those aspects of the disease which are essential to an understanding of its epidemiology wh·ch in turn forms the basis of the control programme. No reference is made to the treatment of poliomyelitis but diagnosis and pathology are referred to briefly.

Poliomyelitis is an acute infection of man due to a specific virus with moderate fever and varying symptomatology. In a typical case of paralytic poliomyelitis, three phases have been described :
1. The <u>incubation phase</u> which is the period between the moment of infection and the onset of the disease. The duration of this phase is not definitely known but it probably ranges from 5 to 35 days, 10 days being taken as the average figure. Symptoms may be vague and indefinite during this phase or they may be entirely absent.
2. During the next phase, the [illegible] e symptoms are present, such as headache, [illegible] pains, restlessness, etc. Its durati[illegible] 3 to 6 days
3. It is followed by the <u>paralytic phase</u> with the onset of paralysis at one or more sites.

This is the mode of progression of paralytic poliomyelitis. It is most important to remember that not every person infected with poliomyelitis virus passes through these phases and ends up in paralysis. On the contrary, there is overwhelming evidence to show that the vast majority of infected persons escape paralysis, some of

2.2. *Diagnosis*:

During epidemics, the diagnosis of acute paralytic poliomyelitis does not present much difficulty. It can be made with reasonable certainty on the strength of the following findings: a history of fever, headache, sorethroat, pain in muscles, vomiting, etc; evidence of paralysis usually in asymmetrical muscle groups and characteristic changes in the C.S.F. The C.S.F. changes are pleocytosis due to polymorphs in the early stages and lymphocytes later on and increase in protein content.

The diagnosis of abortive and non-paralytic poliomyelitis is beset with difficulties, especially in a non-epidemic setting. History of contact with a known case of acute paralytic poliomyelitis is of value. The presence of characteristic changes in the C.S.F. is of help in diagnosing the nonparalytic form. In either type, the ultimate burden of proof of poliomyelitis must lie in the isolation of poliomyelitis virus from the patient and demonstration of the development of homologous or homotypic virus-neutralising antibody during convalescence.

2.3. Pathology:

Before concluding this section, reference may be made briefly to the lesions in the nervous system which form the anatomical background to the varied manifestations of poliomyelitis. The virus is highly neurotropic and attacks primarily the nerve cells. The nerve cells undergo degeneration and necrosis which is accompanied by a copious inflammatory cellular reaction. Three types of inflammatory cells are observed - polymorphonuclears, microglia and lymphocytic cells. The lymphocytic cells are present diffusely in the initial stages of injury but later on persist as perivascular accumulations. The anterior horn cells of the spinal cord are particularly susceptible and some parts of the brain are more commonly affected than others. The brainstem including the hypothalamus and thalamus bears the brunt of the attack. The nuclei of cranial nerves and of the cerebellum are also frequently involved.

3. The Virus of Poliomyelitis

3.1. Characteristics of Poliomyelitis Virus:

3.1.1. Immunological Types: Although it is customary to refer to the aetiological agent of poliomyelitis as "the poliomyelitis virus" as if it were a single entity, recent investigations have differentiated three distinct and separate immunological types of poliomyelitis virus. These have been designated as Brunhilde so called after the chimpanzee at Johns Hopkins or

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paralyse or kill the host and when it does so, it produces lesions in the central nervous system very closely similar to those of poliomyelitis.

Secondly, there is a group of viruses known as Coxsackie, named after the village of Coxsackie in New York, which were discovered as recently as 1947 by Dalldorf. Some 14 different types of Coxsackie viruses have already been isolated. The Coxsackie viruses possess the unusual property of being infective to infant mice but not to older mice. They produce a variety of clinical syndromes in man which run a self-limited course. The greatest difficulty lies in differentiating Coxsackie infections from the milder forms of poliomyelitis. The clinical features and epidemiology of Coxsackie and poliomyelitis infections are closely similar. The two infections not infrequently affect the same locality at the same time..

Lastly, there is the MM-Colombia-SK-Encephalomyocarditis group of viruses. These are highly pathogenic to mice and other laboratory rodents but how frequently man is infected with them is not known. There is evidence to show that the encephalomyocarditis virus is infective to man producing a three-day fever with headache and stiffness of the neck. In laboratory rodents it produces an encephalomyelitis and a necrotising myocarditis.

3.2. Poliomyelitis Viruses in India:

Iyer, Swaminathan, Bharadwaj and Gharpure of the Poliomyelitis Research Unit of the Indian Council of Medical Research have isolated so far 65 strains of poliomyelitis virus. The isolations were made either from the brain and spinal cord of fatal cases or from the stools of clinical cases and their contacts. Twentythree of these strains have been typed, twentyone by Dr. Bodian of the Poliomyelitis Laboratory at Baltimore (U.S.A.) and recently two in the Unit itself where typing facilities became available to a limited extent. Of these, twentytwo belonged to the Brunhilde type and one to the Lansing type. In collaboration with Dr. Bodian the Unit has also undertaken a study of the neutralising antibody content of sera obtained from acute and convalescent cases of poliomyelitis and from a random sample of the general population. 64 serum specimens have been subjected to the study Antibodies against all these types of viruses were present in age groups over 5 years. These results clearly show that all the three types of poliomyelitis virus are present in the environment in Bombay. Likewise, Banker's study of 84 sera collected in 1951 from normal inhabitants of Bombay city, representing various age-groups, showed that about 90% of the sera from subjects four years of age and above contained neutralising antibodies to the Lansing type of poliomyelitis virus suggesting thereby that the virus is highly endemic among the sampled population.

4. Epidemiology of Poliomyelitis

4.1. General Considerations

4.1.1. The Working Hypothesis: Knowledge about the epidemiology of poliomyelitis is still far from complete and there is considerable disagreement about many of its cardinal points. This is not the place for a lengthy discussion of debatable matters and so the account given here will be limited to the presentation of a working hypothesis based on existing scientific evidence which serves to explain the recent trends in the epidemiological behaviour of poliomyelitis. Briefly stated, it is that poliomyelitis is almost world-wide in its distribution affecting all continents; it attacks almost everybody and does so repeatedly so that it may be regarded as one of the most intensely endemic infections to which man is susceptible. The exceptions to this world-wide endemicity are such infinitesimal populations living in isolated regions of the world as the Eskimos in far northern Canada and Alaska and the populations of many small islands of extremely difficult access.

This hypothesis serves to explain the two basic trends in the evolution of poliomyelitis, viz. its transition from an endemic to an epidemic one in some of the advanced countries of the world and the shift in incidence towards higher age groups in these countries. The reasoning is as follows: In the 'under sanitated' parts of the world, most children are infected with poliomyelitis by about the age of four years. From earliest infancy, they are exposed to the virus. During the first year of life, they are protecteu from infection by the passive immunity conferred on them by their abundantly immune mothers through breast milk. By about the end of their first year of life, they begin to lose this passive immunity and the virus to which they have been constantly exposed then merely serves to "vaccinate" them against the disease. In the process, many children develop a mild infection in the form of abortive or non-paralytic poliomyelitis. An occasional child comes down with paralytic poliomyelitis. In view of the heavy pollution of the environment with poliomyelitis viruses in these parts of the world, repeated infections with each of the locally prevalent immunological types probably occur, thus helping to build up effective and durable immunity at an early age. On the other hand, in the better sanitated areas of the world, the improvement in general hygiene diminishes the risk of coming into contact with the virus at an early age, with the result that an appreciable number of completely non-immune persons are present in the higher age groups in the community. When the virus is introduced into such communities, the disease assumes epidemic proportions and clinical poliomyelitis becomes increasingly common in persons of older ages. When infection has been absent for a generation or more in a community as in the case of some of the remote islands, the introduction of a virulent strain

of poliomyelitis virus will be expected to result in a violent outbreak affecting all age-groups,in particular the older age groups.

4.1.2. Geographical and Racial Factors: No geographical unit nor any racial group is exempt from poliomyelitis. As already stated, the trends in the geographical and racial distribution of poliomyelitis are perhaps best explained by the latent immunity hypothesis. For a very long time, poliomyelitis was not regarded as an important problem in tropical countries but, since the last war, epidemics are being increasingly reported in them and it appears likely that this trend will continue. To illustrate: first, there were the 1942 epidemic in Peurto Rico, followed by the epidemics in '46 and '51, the '44 epidemic in Costa Rico, the '45 and '48 epidemics in the Union of South Africa, the '50 epidemic in Belgian Congo, the '51 epidemic in French Equitorial Africa and the '50 epidemic in Palestine. Nearer home, mention may be made of the '47 epidemic in the Nicobar Islands, the '48 epidemic in Ceylon and of the recurrent epidemics since 1949 in India. During this period, severe outbreaks were also reported from a number of islands - in Malta in '42, Mauritius in 1945, St. Helena in the same year and Car Nicobar in 1947 as referred to above.

Although all races are susceptible to poliomyelitis, there are differences in the incidence of the disease in the various racial groups. Thus in some states of the U.S.A., it is four times as common in children of the whites as in the Negroes. In South Africa, it is ten times as common in persons of European descent as in the Bantu. It has been reported that in the Mauritius epidemic in 1945 the incidence of poliomyelitis was higher in Chinese and Indians than in the other communities.

4.1.3. Climatic Factors: Seasonal variations in the occurrence of paralytic poliomyelitis are very striking for which there is no really satisfactory explanation. The disease is far more prevalent in the so-called temperate zones during the summer months and a similar trend is seen in recent years in the tropical epidemics also. The incidence curve is based on paralytic cases because they are the only ones that can be diagnosed with any degree of accuracy. Careful enquiry into the occurrence of abortive and nonparalytic cases reveals that their seasonal incidence runs parallel to that of paralytic cases. Supporting evidence in favour of seasonal variations in incidence is provided by the results of a systematic search for *poliomyelitis virus* in sewage. The virus is found only during the "polio season" and not at other times of the year. Of the climatic factors, temperature, rainfall and humidity are believed to be important, but there is no good explanation as to how they influence the incidence.

4.1.4. Nutritional Factors: Here lies yet another paradox in poliomyelitis. While it is generally believed but notsatisfactorily shown that under-nutrition and malnutrition increase the susceptibility of an individual to a variety of infections, the state of nutrition of the population seems to have no decisive influence on the incidence of poliomyelitis. However, the incidence of paralytic attacks is distinctly lower in many under-nourished parts of the world where the disease is endemic than in the well-nourished and advanced countries. It is not clear whether this is because undernutrition is also invariably associated with insanitary conditions of living with opportunities for developing immunity at an early age or whether undernutrition and malnutrition per se exert a distinct influence on incidence. In this connection, it is of interest to recall that in experimental poliomyelitis in mice, deficiency of some members of the B group of vitamins and of calories in the diet increases the resistance of the animals to infection.

4.1.5. Predisposing Factors: Epidemiological studies in poliomyelitis indicate that trauma of diverse types acts as a predisposing factor in the production of clinical disease. Thus, it has been shown that there is a significantly higher incidence of bulbar poliomyelitis in persons who have been subjected to tonsillectomy within the previous month. In such cases the virus is believed to spread to the medulla through the cranial nerves supplying the pharynx. Intramuscular injections given within a month of exposure to infection seem to predispose the injected limb to paralysis. This effect has been demonstrated particularly strikingly with injections of the combined diphtheria-pertussis vaccine. There is some evidence to show that intercurrent infection and overexertion at the time of the onset of clinical disease are conducive to the development of severe paralysis.

4.1.6. Sources of Infection:

(a) Nasopharynx: The virus has been isolated from the throats of cases of poliomyelitis and of their contacts. It can be detected in the nasopharynx for 3 to 5 days before and for 3 to 7 days after the onset of symptoms.

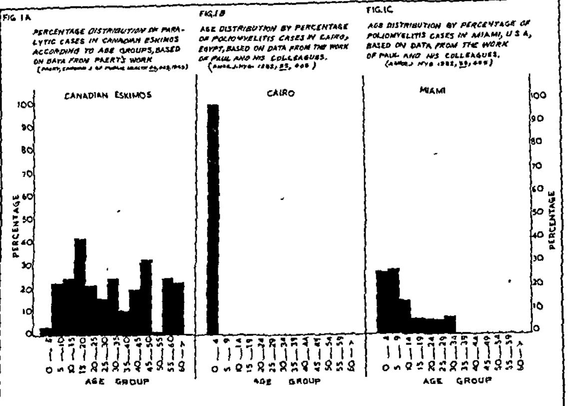
(b) Faeces: Contrary to earlier belief, it now appears that the faeces constitute a more important source of infection than nasopharyngeal secretions. The virus may be detected in the stool for several days before and for as long as 2 to 6 weeks after the onset of symptoms. Furthermore, vary large quantities of virus are excreted in the stool; it has been estimated that as many as a million infectious doses for monkeys may be present in one gram of faeces. Sewage from infected localities has been shown to contain the virus.

It might be mentioned that both abortive and nonparalytic cases of the disease harbour the virus in their throats and excrete it in the faeces just like the paralytic ones. These persons also form an important source of infection.

4.1.7. Mode of Spread: It is now generally accepted that poliomyelitis is a highly infectious disease and that it spreads by direct contact with an infected person. It has been suggested that infected sewage may play a significant part in the spread of the disease. There is evidence to show that the virus can survive several stages of purification of sewage and when untreated or partially treated sewage finds its way to streams and rivers, wide-spread dissemination of the virus may occur. Contaminated milk and vegetables have also been suggested as important vehicles of spread but to date there are few authentic records in support of these suggestions. This aspect requires further investigation.

The question of transmission of the virus of poliomyelitis by arthropods has been investigated in some detail and the virus has been isolated from flies and cockroaches. These, however, seem to act as mechanical carriers only, for there is no evidence to show that the virus multiplies in them. Although flies are not essential for the spread of the disease, where they are abundant, as in the hygienically backward localities, they have been shown to play a significant part in spreading the disease.

4.1.8. Entry, exit and distribution of virus within the bo
In view of the fact that the virus can be recovered from the thro
and that monkeys can be infected by nasal instillation of infecti
material, it used to be believed for a long time that man becomes
infected through the respiratory tract by droplet infection. Rece
studies, however, tend to show that the alimentary route is perh
a more important portal of entry of the poliomyelitis virus. Dur
the later stages of an acute attack, the virus can be detected i
the faeces even when none can be found in the throat. This is
to indicate that the virus probably multiplies within the tissu
the alimentary tract. The gastro-intestinal route is also the
of excretion of the virus. The virus has never been isolated e
in saliva or in urine. Until recently, it was believed that th
virus reaches the central nervous system via the nerves but ev
it was demonstrated in the blood stream in men and monkeys bef
onset of symptoms, many are of the opinion that the virus is c
to the C.N.S. through the blood stream.


FIG 1A
PERCENTAGE DISTRIBUTION OF PARALYTIC CASES IN CANADIAN ESKIMOS ACCORDING TO AGE GROUPS, BASED ON DATA FROM PEART'S WORK
CANADIAN ESKIMOS
PERCENTAGE
AGE GROUP
FIG. 1B
AGE DISTRIBUTION BY PERCENTAGE OF POLIOMYELITIS CASES IN CAIRO, EGYPT, BASED ON DATA FROM THE WORK OF PAUL AND HIS COLLEAGUES.
CAIRO
AGE GROUP
FIG. 1C
AGE DISTRIBUTION BY PERCENTAGE OF POLIOMYELITIS CASES IN MIAMI, U S A, BASED ON DATA FROM THE WORK OF PAUL AND HIS COLLEAGUES.
MIAMI
PERCENTAGE
AGE GROUP

studied extensively until Enders and his colleagues introduced the tissue culture technique for growing poliomyelitis viruses. In 1949, Enders and his colleagues demonstrated for the first time that poliomyelitis viruses can be grown in vitro in extraneural tissues of human and simian origin and that in the process of their growth, they destroyed the cells of the tissues. It is hard to overestimate the importance of this discovery. It has not only enabled qualitative and quantitative estimation of neutralising antibodies in human sera to all known types and strains of poliomyelitis virus with speed and economy, but has also proved to be most valuable in the isolation, typing and assessment of virulence of poliomyelitis viruses, in the preparation of antigens, in the study of the effect of drugs and antimetabolites on the growth of the viruses and most important of all, in the production of large quantities of virus for use as vaccines. Indeed, it is this discovery which has paved the way for the development of antipoliomyelitis vaccine by Salk. And it was for this discovery that Enders and his colleagues were awarded Nobel Prize in 1954.

Increasing use is being made of the tissue culture technique in surveys of the immune status of population groups. These and earlier studies have shown that both virus-neutralising and complement-fixing antibodies develop early in the course of poliomyelitis. The presence of neutralising antibody against a certain type of poliomyelitis virus is indicative of the individual having been exposed to infection with that type, either in recent or remote past. Neutralising antibodies persist in the blood for a long time whereas the complement-fixing antibodies do not remain elevated for longer than about three years and so their presence is indicative of recent infection only. A study of neutralising and complement-fixing antibodies in different age groups in a community gives a more or less comprehensive picture of the story of poliomyelitis in that community.

Numerous immunological surveys with the aid of the techniques mentioned above have been made in various parts of the world, the results of which provide the basis of our present concept of poliomyelitis as a world problem. Results of such surveys carried out in each of the three areas which have been chosen earlier for discussion of age distribution of paralytic poliomyelitis in relation to immunity may be quoted here. Thus in the Eskimo community, it has been shown that there is dearth of neutralising antibodies to all the three types of virus in a substantial proportion of young adults, suggesting that the community had not been exposed to the virus for many years. Whereas in Egypt which is a highly endemic area, Lansing antibodies are acquired speedily, almost 100% of children over the age of 2 years showing their presence. The situation in countries with high standard of environmental sanitation, such as the U.S.A., is intermediate between these two extremes. For example, in one survey (Cincinnati) it was shown that by the time the children reached five years of age,

only 40% of them had acquired antibodies to the Lansing strain. In figure 2 are shown the earliest ages at which 50% of the population living in each of the three representative areas mentioned above, namely, Alaska, Egypt and U.S.A. develop antibodies to the Lansing strain.

4.2. Epidemiology of Poliomyelitis in India

4.2.1. Incidence in general

4.2.1.1. The existing records do not permit assessment in precise terms of the incidence of poliomyelitis in India as a whole over the years. The disease was made notifiable in the States of Bombay and Delhi only in 1949, and in the Punjab, Assam, Madhya Pradesh and Uttar Pradesh in 1952. It appears that it is not notifiable in others States at present. However, an analysis of the existing data made by the Director-General of Health Services, New Delhi, which are described in the next section, has revealed some interesting trends. It would be hazardous to draw any firm conclusions from them since they are based upon annual hospital returns from a few States in the country. The degree of uncertainty is further increased in the absence of information about the sizes of the population from which the hospitals obtain their clientale. Unfortunately, it has not been possible to obtain a complete list of hospitals from which these cases have been reported.

4.2.1.2. In the accompanying table are summarised the actual hospital returns of cases of paralytic poliomyelitis from some of the States In India. They merely serve to show, within the limitations referred to above, that the disease occurs in various parts of the country but in varying intensities. (The figures for Greater Bombay are considered separately.) To quote: "The number of cases reported from each of the States of Punjab, Madras and Delhi, are fairly large and these have been statistically analysed". These have been subjected to further analysis. In figures 2A, 3 and 4 are plotted the actual returns for each of these states together with the moving averages with a free-hand curve passing through them and indicating the general trend in incidence. "It will be noted that the data for Punjab show an upward tendency, almost linear, during 1950-53 and a downward trend during 1953-54," while those for Madras show "a steep downward tendency during 1950-51 which was reversed after the September minimum of 1951 and became steady thereafter. Returns from the Delhi State show a steady upward trend during 1950-52 and steeper downward trend during 1952-54."

4.2.1.3. As for seasonal variations in incidence, it is clear from a perusal of the figures (2A, 3 and 4) that paralytic cases

FIG 2

SHOWING THE EARLIEST AGES AT WHICH 50% OF THE POPULATION IN THREE SELECTED AREAS DEVELOP ANTIBODIES TO LANSING STRAIN

DATA FOR EGYPT AND ALASKA ARE FROM THE WORK OF PAUL AND HIS COLLEAGUES (AMER. J. HYG., 51, 210, 1950 AND 55, 410, 1952) DATA FOR U.S.A. ARE FROM A REVIEW BY HAMMON (BACT. REV., 13, 135, 1949)

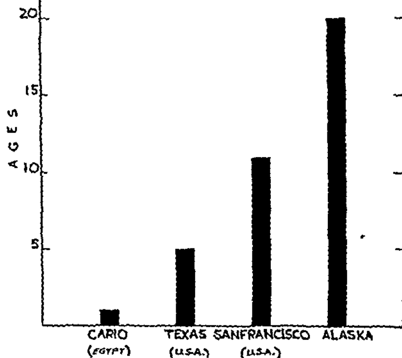
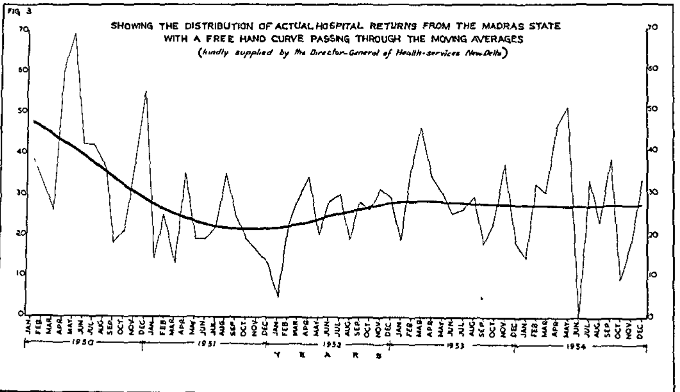
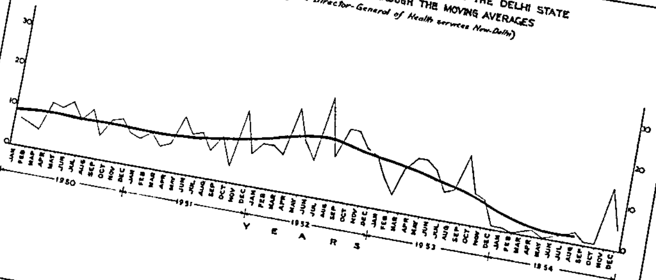


TABLE SHOWING CASES OF POLIOMYELITIS REPORTED FROM SOME STATES

STATE	PERIOD				
	1950	1951	1952	1953	1954
Punjab.	141	217	314	397	344
Delhi.	110	112	173	-	-
Madras.	478	256	301	340	326
U.P.	79	63	105	85	63
West Bengal	-	8	80	109	121
Madhya Pradesh.	14	9	31	7	-
Ajmer.	-	11	19	15	28


FIG 3
SHOWING THE DISTRIBUTION OF ACTUAL HOSPITAL RETURNS FROM THE MADRAS STATE
WITH A FREE HAND CURVE PASSING THROUGH THE MOVING AVERAGES
(kindly supplied by the Director-General of Health-services New Delhi)
0
10
20
30
40
50
60
70
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1950
1951
1952
1953
1954
YEARS


FIG 4
SHOWING THE DISTRIBUTION OF ACTUAL HOSPITAL RETURNS FROM THE DELHI STATE
WITH A FREE HAND CURVE PASSING THROUGH THE MOVING AVERAGES
(kindly supplied by the Director-General of Health services New-Delhi)
30
20
10
0
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1950
1951
1952
1953
1954
YEARS

occur throughout the year. However, when the seasonal indices and effects are calculated from the fortnightly returns available for the three States of Punjab, Delhi and Madras (results not reproduced here), it was found that for Punjab "these seasonal indices showed a well marked maximum in April, with two subsidiary rises in August and October and a definite minimum in February." The seasonal effects in Madras and Delhi were generally similar to those observed in the Punjab except for slight differences in the minimal and subsidiary maximal seasonal indices.

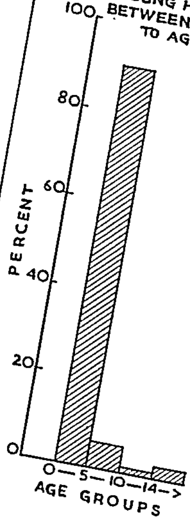
4.2.1.4. Reports of individual cases treated in Safdarjung Hospital, New Delhi, for five consecutive years from 1949-54 are also available. When arranged according to age groups, it was found that 90 percent of the paralytic cases occurred in the 0-5 year age group, thus indicating that the disease is endemic in Delhi and that the adult population is highly immune to it (Fig. 5).

4.2.1.5. Although the data presented here are obviously inadequate, they indicate that paralytic poliomyelitis occurs in widely scattered areas all over the country. Judging by the age incidence it would appear that it is highly endemic in India. Cases occur throughout the year but a definite seasonal effect is also seen. The slight differences observed in seasonal incidence in the different parts are to be expected in view of the climatic differences in them. Actually, India itself is too large for any wide generalisations to be made in this regard. Thus, while Southern India is in the tropics, most of Northern India is sub-tropical and some of it in the temperate zone. India, therefore, offers a fertile field for study of the role of climatic factors in the spread of the disease.

4.2.1.6. The conclusion drawn from the data quoted above that poliomyelitis is an endemic disease in India and that the virus is present in abundance in the environment is further supported by the fact that paralytic poliomyelitis was frequently contracted by British soldiers serving in India during the second world war, while it rarely affected the Indian troops. The explanation that offers itself is that unlike the British troops, the Indian troops were immune to the locally prevalent strains of poliomyelitis virus.

4.2.2. Poliomyelitis in Bombay

The work of the Poliomyelitis Research Unit of the I.C.M.R. in Bombay has thrown some light on the epidemiology of the disease in that city and its suburbs. Except for the city of Bombay and its suburbs and a town, called Dohad, about 300 miles to the north of Bombay City, there is no evidence to show that poliomyelitis

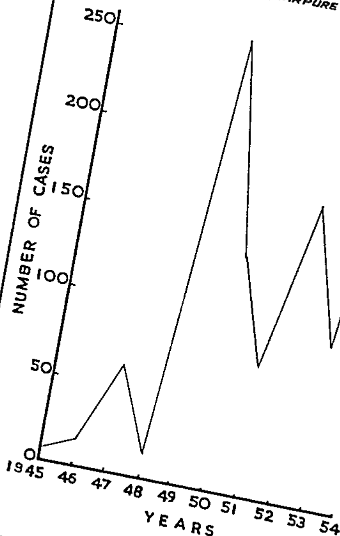

FIG.5
PERCENT-DISTRIBUTION OF PARALYTIC CASES ADMITTED TO SAFDARJUNG HOSPITAL, NEW-DELHI, BETWEEN 1949-54 ACCORDING TO AGE GROUPS
TOTAL NUMBER, 396
100
80
60
40
20
0
PERCENT
0—5—10—14—>
AGE GROUPS

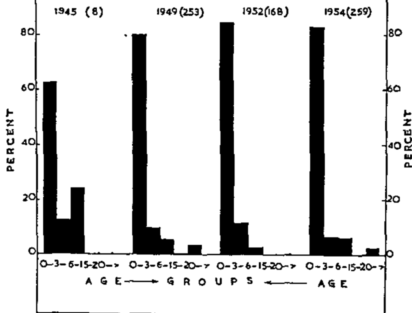
has assumed epidemic tendencies in any other part of the country. Poliomyelitis took an epidemic turn in Bombay for the first time in 1949. Since then two more outbreaks occurred, one in 1952 which was rather moderate sized and the other in 1954 which was as severe as the 1949 epidemic (Fig.6). Available records prior to 1949 show that the disease had been sporadic in occurrence. Analysis of the records according to age groups shows that the maximum incidence of the disease during the pre-epidemic period is in the 0-4 year age group indicating its extreme endemicity in this locality. (Fig.7). During the epidemics of 1949, 1952 and 1954, this pattern of age distribution has been maintained (Fig.7). This may be taken to indicate that the epidemics are probably due to one or other of the locally prevalent strains of the virus.

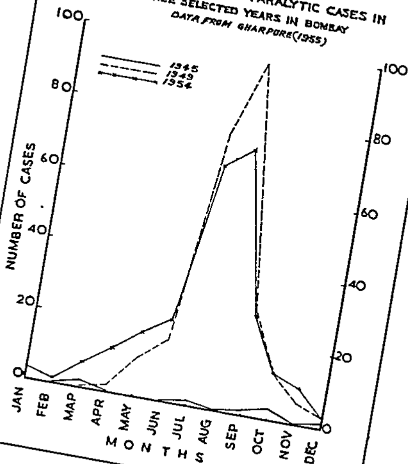
The epidemics show a clearcut seasonal effect. (Fig.8). While in the pre-epidemic period, the disease occurred throughout the year, with no definite seasonal predominance, the epidemics are sharply restricted to the hot summer months of the year (July and August). These are the months when Bombay is subjected to heavy rains from the South-West monsoon. It is interesting to record that epidemic years 1949, and 1954 were characterised by very heavy rainfall. In view of the undue sensitivity of the poliomyelitis virus to desiccation, it is tempting to speculate that the epidemic transformation of the disease in July and August is probably at least in part related to the extremely damp and humid environment during those months.

Other features of the epidemiology of poliomyelitis in Bombay are the following: The paralytic form of the disease is equally distributed between the sexes; the largest number of cases have been reported from the most thickly populated parts of the city; the first epidemic in 1949 occurred at a time when the sweepers of the city of Bombay went on a general strike and when filth and dirt accumulated in heaps on the roadside.

Virological and immunological studies carried out in Bombay by the Council's Unit have already been referred to (3.2.). They show that the strains of virus so far isolated fall into one or other of the three known types of poliomyelitis virus. The unit has also found neutralising antibodies against all the three types of poliomyelitis in a high proportion of the sera from persons over the age of 5 years in Bombay. These findings together with Banker's immunological survey of representative samples of the population of Bombay according to age groups and the pattern of age distribution of cases leave no doubt that poliomyelitis has been endemic in Bombay. There is, however, no definite clue as to why it has assumed epidemic proportions since 1949.


FIG. 6
SHOWING THE ANNUAL INCIDENCE OF PARALYTIC POLIOMYELITIS IN BOMBAY SINCE 1945.
DATA FROM GHARPURE (1955)
NUMBER OF CASES
0
50
100
150
200
250
1945
46
47
48
49
50
51
52
53
54
YEARS


FIG. 7
SHOWING THE AGE DISTRIBUTION CASES AT VARIOUS TIMES IN BOMBAY. FIGURES IN BRACKETS RELATE TO TOTAL NUMBER OF CASES (BASED ON DATA FROM GHARPURE—1955)
1945 (8)
1949 (253)
1952 (168)
1954 (259)
PERCENT
0
20
40
60
80
0-3-6-15-20→
AGE → GROUPS ← AGE


FIG 8
SEASONAL DISTRIBUTION OF PARALYTIC CASES IN
THREE SELECTED YEARS IN BOMBAY
DATA FROM GHARPURE (1955)
1945
1949
1954
NUMBER OF CASES
100
80
60
40
20
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
MONTHS

4.2.3. Dohad Epidemic

Poliomyelitis took an epidemic turn in the small town of Dohad in 1952. Prior to that, the incidence of poliomyelitis in Dohad was extremely low, about 4-6 cases being recorded every year. In 1952, 75 cases were recorded from May to July giving a calculated attack rate of about 200 per 100,000 population. 90% of the cases occurred in the age group 3 years and below, thus indicating the high degree of immunity of the older section of the population. The very restricted age range of the vast majority of the cases in Dohad suggests the immunological similarity of the virus strain responsible for this epidemic to those existing there previously. A Brunhilde type of poliomyelitis virus was isolated from the faeces of one of the cases.

4.2.4. The Car Nicobar Island Epidemic:

The Car Nicobar Island Epidemic presents a striking contrast to the epidemics recorded in Bombay City. The first case in Car Nicobar appeared on the 12th November, 1947. The disease was apparently unknown in the island before this date. By the middle of December the epidemic had completely subsided. 800 cases of poliomyelitis with 400 deaths were reported during this 2 months period in a total population of about 10,000. There was an usually high incidence of bulbar poliomyelitis. All age groups were affected (Fig. 9). The 6-10 year group was the most severely affected. When the remaining age groups are arranged in the order of attack rates: considerable scatter is found which suggests that the virus had invaded virgin territory. The disease attacked only the Nicobarese; none of the 70 Indians living in the islands at the time was affected.

There is considerable uncertainty about the source of the epidemic. According to some, the infection was introduced by a group of persons who visited Nicobar from a neighbouring island which the Japanese were using as an isolation island for infectious diseases during the Second World War. According to others, there was evidence to show that the infection was introduced from Port Blair where sporadic cases had been occurring and which was visited by one or two inhabitants of Nicobar a few days before the outbreak.

The Nicobar epidemic is a classical example of epidemic poliomyelitis in a highly susceptible population, living in remote parts of the world. Other examples of similar outbreaks are the St.Helena epidemic in 1945 and the epidemic among the Eskimoes of Canadian Arctic in 1949 already referred to (4.1.9).


FIG. 9
PERCENT. DISTRIBUTION OF CASES ACCORDING TO AGE GROUPS IN THE NICOBAR EPIDEMIC
DATA FROM MOSES (1948)
PERCENT
20
15
10
5
0
0—5—10—15—20—25—30—35—40—45
AGE GROUPS

Immediately upon receiving news about the Nicobar epidemic, the Government of India had sent out a team of experts consisting of physicians, pathologists and surgeons to investigate the disease. The findings of the team have been publiched only in parts (Moses and Kapila). Some of the unpublished findings of the team may be briefly recapitulated here. The infection was apparently introduced from outside Nicobar. The living and housing conditions of the people were <u>par excellence</u> in favour of contact infection. Flies did not appear to play a role in spreading the infection. Food contamination could be ruled out. No abnormal dietetic or climatic conditions preceded the epidemic.

The clinical features of the disease were similar to those described elsewhere and need not be mentioned. Treatment was along the usual lines and iron lungs were flown from India for the purpose. Mention may be made of the special efforts made to organise in a scientific manner the orthopaedic treatment of the disease in order to help the patients in their recovery and rehabilitation. The main occupation of the Nicobarese, the coconut trade, involves climbing of coconut trees. Centres for educative exercises and massage were started in various places under the direction of the late Dr. Kini.

Efforts were made to isolate the virus. Monkeys were transported from India by air to Nicobar and two of them were successfully infected with faecal material at the King Institute in Madras. It would be interesting to study the poliomyelitis problem in Nicobar now particularly, studies on the immune status of the population. A search for the virus in the community should provide valuable information.

5. <u>Control of Poliomyelitis</u>

5.1. <u>Introduction</u>:

Had this Chapter been written a few months back, it would have struck a rather disappointing note, for until the results of trials with the Salk vaccine had become known, the public health measures usually recommended for the control of poliomyelitis were known to be little or no value. The Salk antipoliomyelitis vaccine has been shown to be highly effective in the prevention of poliomyelitis. The control of epidemic poliomyelitis on a mass scale is now in sight and there is every reason to expect that in the near future it will be regarded as preventable a disease as small-pox or diphtheria.

It is too early at this stage to assess the role of the usually advocated general hygienic measures in the prevention of poliomyelitis in the context of vaccine development. Maybe they will assume a new significance and importance which future work alone will bring to light. While in the past, improvement in environmental sanitation and living standards almost always resulted in the accumulation of a large number of highly susceptible persons in the community thus creating conditions favourable for an epidemic outbreak, now, since successful artificial immunisation has become possible, such an improvement in living standards may indeed prove to be of supplementary value in the control of poliomyelitis. In this chapter, the control measures, therefore, are discussed under two headings: (i) General Control Measures and (ii) Measures for inducing specific immunity. Since this memorandum is primarily written for administrative health officers, this section is dealt with in some detail even though no work on the preventive aspect of the disease has been done in India.

5.2. General Control Measures:

5.2.1. The general measures which have hitherto been recommended for the control of poliomyelitis infection in the community are based on some of the essential features of the epidemiology of the disease. Attention has already been drawn previously to the trend of events in some of the Western Countries with special reference to the conversion from the sporadic to the epidemic form of disease and the shift in age incidence. It has also been stated that the virus is present in the environment generally being transmitted through faeces and to a lesser extent from nasopharyngeal secretions. Even so, infection is usually attributed to direct contact. A factor of great importance in the epidemiology of poliomyelitis which must be mentioned is that for every person showing paralytic disease, there are many others who have been infected but who do not show the symptoms of the disease. The actual estimates of the proportion of symptomless infected persons to those with clinical disease vary from place to place and at different times in the same place. According to some estimates in epidemic areas there may be as many as 100 symptomless infected persons for every one person with paralytic disease. Under these conditions, it is easy to understand the limited usefulness of standard public health procedures such as isolation and quarantine in checking the spread of the disease.

5.2.2. There can be no two opinions about the need for notification of all cases of poliomyelitis, whether or not the disease is epidemic or endemic. It is suggested that poliomyelitis should be made notifiable throughout the Indian Union immediately. On the question of isolation, existing knowledge does not enable us to take a firm stand. How long should a person be isolated and where? It is usual to isolate patients for one to three weeks after the onset of clinical disease, but recent studies indicate that this is probably

too short a period. Should a patient be isolated in the home or in the hospital? What measures should be adopted when there is an outbreak in a nursery, school or residential institution? Should the institution be closed, if so, for how long? How is the isolation of cases and their immediate contacts to be enforced in such institutions? Finally, one has to consider the measures to be directed against the virus itself. Here, a knowledge of the physical and chemical properties of the virus has proved to be of some value. For example, since the virus can be killed at a temperature of 60° for 30 minutes, disinfection by means of heat can be practised with safety or again since iodine is more powerful than chlorine and the usual antiseptics such as alcohol, ether, etc., it would appear to be desirable to disinfect the skin by means of tincture iodine before giving a parenteral injection.

These and other problems will have to be considered by the public health administrators in dealing with the poliomyelitis problem. The first meeting of the W.H.O. Expert Committee on poliomyelitis examined in detail the role of general control measures in checking the spread of poliomyelitis, and have made clearcut recommendations on their applicability. In view of the importance of this subject, relevant extracts from this report are reprinted here as 'Appendix 1'.

5.3. <u>Measures for Inducing Specific Immunity:</u>

5.3.1. <u>Passive Immunity</u>: With the inefficacy of the standard public health measures described above to materially check the spread of epidemic poliomyelitis, attention began to be focussed on immunisation. The possibility of conferring effective passive immunity was explored by Hammon. <u>Human gamma globulin</u> prepared from pooled blood from several thousands of donors in the U.S.A. was found to contain antibodies against all three immunological types of poliomyelitis virus. It conferred protection against experimental poliomyelitis in monkeys and rodents. In man it was found to exert a significant degree of protection against paralytic poliomyelitis. Its mode of action is still <u>subjudice</u>. It cannot prevent infection of the individual with poliomyelitis virus, nor has it any influence on the carrier state but it seems to act by blocking the invasion of the central nervous system by the virus, thus preventing the development of paralysis. By virtue of the "broad spectrum" antibody content of gamma globulin prepared from large pools, passive immunisation even seemed to score a point over active immunisation done with one strain of each recognised virus type. Unfortunately, the passively conferred antibodies decline rather rapidly in a linear fashion. As shown in children, their effective concentration in blood after injection lasts for about 21 days only. A little reflection of the epidemiology of poliomyelitis will show how extremely limited will be the usefulness of gamma globulin in controlling epidemics.

Since there is no way of predicting which child will develop paralysis in an epidemic, all children in a given area will have to be inoculated with gamma globulin. In view of its high cost and limited supply, this would appear to be a wasteful procedure. Furthermore, even when used for mass prophylaxis, the timing of the injections is extremely important. Since the maximum effectiveness of gamma globulin is probably reached by about three weeks after injection, theoretically, the injections would have to be so timed as to precede the peak of the epidemic by this period. As there is no way of predicting the course and severity of an epidemic, the usefulness of passive immunisation in mass prophylaxis is thus severely restricted. In spite of these drawbacks, however, there are some situations in which its use seems to be indicated. It may be employed with benefit in preventing the disease in familial and other intimate contacts of clinical cases, and in checking institutional outbreaks. The recommended dosage is 0.31 ml. per k.Gm. of body weight, given intramuscularly.

5.3.2. Active Immunisation

5.3.2.1. The Salk Vaccine: Those who have studied closely the problem of poliomyelitis have come to the conclusion long ago that the ultimate solution to its prevention lies in active immunisation. Even in the early 1930's, a number of workers, notably Brodie and Kolmer, had shown that monkeys could be rendered resistant by administration of either live or killed virus vaccines. However, until recently, technical difficulties in the isolation, propagation and behavioural study of poliomyelitis viruses have hindered progress in this field. The experimental vaccines prepared by the earlier workers contained the poliomyelitis virus suspended in nervous tissue, with the attendant risk of producing encephalomyelitis in the recepient. The first break-through came in 1949 when Enders and his associates at the Harvard Medical School discovered that the poliomyelitis viruses can be grown *in vitro* in non-nervous tissues of human and monkey origin. This discovery, by readily making available large quantities of poliomyelitis virus, marked the first and the most important step in the development of an anti-poliomyelitis vaccine. Other discoveries rapidly followed in its wake. Thus, by 1951, as a result of a mammoth project involving collaborative studies in four major universities for over 3 years in the U.S.A., it became clear that all known strains of poliomyelitis virus could be classified into three distinct immunological types. This meant that an antipoliomyelitis vaccine, to be effective, must contain all the three types of the virus. Then came the discovery in 1952 by Bodian and Horstmann, who, working independently, showed that the virus of poliomyelitis can be demonstrated for short periods in the blood stream before the development of clinical disease. This observation, together with that of Hammon that a measurable degree of protection against poliomyelitis can be conferred by passively transferred immunity provided strong support to the conviction that artificial immunisation induced by means of a vaccine containing all the

three types of poliomyelitis virus would provide effective protection. These observations paved the way for the preparation by Salk in 1953 of a vaccine against the disease. Indeed, by the end of that year a large number of animal experiments and limited human trials had already confirmed its usefulness.

Technically, two types of vaccine are possible - one using killed virus preparations and the other using living avirulent variants. Killed preparations will have to be given parenterally. They must contain large amounts of preformed antigen; they have to be given repeatedly with the attendant risk of sensitisation reactions. On the other hand, live virus vaccines, if and when available, will be easy to administer, they can be given by mouth to simulate the process of natural infection and a long lasting immunity can be built up by a single dose. The antipoliomyelitis vaccine developed by Salk belongs to the former type. The viruses are grown in tissue culture using monkey kidney tissue for the purpose.

The Salk vaccine has been defined as an "Aqueous suspension of inactivated poliomyelitis virus prepared from representative strains of each of the three virus types. Inactivation is accomplished by the use of formaldehyde at suitably controlled acidity, temperature and time. Inactivation is designed to render the virus harmless, but at the same time to maintain its capacity to produce antibodies"(Quoted from the U.S. Public Health Service Technical Report on Salk Poliomyelitis Vaccine, June 1955). The Salk vaccine was recently evaluated in the U.S.A. for prophylactic effectiveness in the largest field trial ever undertaken. The trial was initiated by the National Foundation for Infantile Paralysis (U.S.A.) in the spring of 1954. It was organised by the Poliomyelitis Vaccine Evaluation Centre established at the University of Michigan. The results of this trial, which were published on the 12th April, 1955, have received world-wide publicity. They are briefly recapitulated in the next section.

5.3.2.2. 1954 Field Trial of Poliomyelitis Vaccine: In all, a total of 1,829,996 school children in 211 areas in 44 States in the U.S.A. participated in the evaluation programme. The study areas were carefully selected on the basis of their consistently high poliomyelitis incidence during the past 5 years. The programme involved two types of study - One in the so-called 'Placebo Control' Areas in which 200,745 children received three injections of the vaccine while another batch of 201,229 children received three injections of a placebo which contained neither poliomyelitis virus, nor monkey kidney protein. The other study was in the so-called 'Observed Control' Areas in which the study population totalled 1,080,680 children of whom 221,998 children received three doses of

the vaccine while the others served as uninoculated controls. The vaccine and placebo were each administered in <u>3 injections</u>. The first two injections were 1 week apart while the third was given 4 weeks after the second. Both inoculated and uninoculated children were under observation from May to December, 1954. During this period, a careful watch was kept on the incidence of poliomyelitis in the study population. Whenever cases, even of a suspicious nature, occurred the following investigations were undertaken in them: clinical study, epidemiological study, muscle evaluation at intervals, laboratory study of stool and blood samples for the isolation of the poliomyelitis virus and for detection of antibodies respectively. The reactions following vaccination were also studied. Blood samples were collected from a proportion of children before and at intervals after the third injection, for measuring the antigen potency of various lots of vaccine used.

When the mass of data so collected were statistically analysed, the vaccine was found to be clearly effective in preventing paralytic poliomyelitis. An overall estimate of 75% effectiveness was obtained in the Placebo Control Areas and 62% in the Observed Control Areas. When the results were further analysed with respect to the actual type of infecting virus, and clinical type of the disease, the following information came to light: In Placebo Control Areas, the vaccine was 68 percent, effective against type 1; 100 percent against type 2 and 92 percent against type 3. It was more effective in preventing Bulbospinal forms of the disease than spinal paralytic forms, the estimate of effectiveness being 94 percent against the former and 60 percent against the latter in the Placebo Control Areas. No significant reactions were observed as a result of the vaccination.

Thus it was shown that the Salk anti-poliomyelitis vaccine was a highly effective weapon in the prevention of poliomyelitis. It has been reported that Salk predicted even a 100 percent effectiveness with the new 1955 vaccine and with modified spacing of immunising doses.

5.3.2.3. <u>A Critique of the Salk Vaccine</u>:

<u>Safety of the Salk Vaccine</u>: Before concluding this chapter it must be emphasised that the Salk Vaccine does not mark the end but merely the beginning of a new era of man's attempt at the conquest of poliomyelitis. There are many problems raised by the Salk Vaccine for which satisfactory solutions are still awaited. oremost among these is the question of safety of the vaccine. lthough the searching analysis of the results of 1954 field trial, n which nearly half a million children received the Salk Vaccine,

it can be grown in tissue culture and of its ability to produce a high titre of antibody content in the inoculated individual. It is however an extremely virulent strain and the wisdom of its inclusion in the vaccine has been questioned by many virologists. It has been suggested that the less virulent Brunhilde strain may be used in its place. Apparently this has already been done in Denmark. The antigenic potency of such a vaccine is yet to be determined.

Immunity induced by the Salk Vaccine:

It is not clear as to how long the immunity induced by Salk vaccine would last. The results of measurement of the antigenic potency of Salk vaccine used in the mammoth field trial described above have shown that antibodies persist for four to five months after completion of series of vaccinations but follow-up studies over longer periods are obviously necessary. If it is found that 'Booster' doses have to be given at frequent intervals throughout the lifetime of an individual, then quite apart from the inconvenience of such a procedure the risk of inducing sensitisation reactions will have to be borne in mind.

Studies on antibody response to Salk vaccine had also shown that the response to type '1' was inferior to that of types '2' and '3'. In conformity with this finding is the observation that the vaccination was less effective in preventing infection with type '1' virus than with the other two types. This is rather a serious handicap of the Salk vaccine considering the fact that a majority of outbreaks of polio-myelitis are attributable to the type '1' virus.

Future work alone will show whether these problems can be solved satisfactorily by further refinements in the Salk vaccine or whether one has to wait for the day when the manufacture of a suitable avirulent live virus vaccine becomes a possibility. Work on the live virus vaccine is still in an experimental stage and developments in this field will be awaited with great interest.

5.4. General Comments and Conclusions

5.4.1. In view of the wide-spread public interest in the Salk vaccine, it may be profitable here to examine the question whether or not the vaccine should be used for mass prophylaxis against poliomyelitis in India at the present moment. For this purpose, it is essential

magnitude as to warrant the institution of a mass control programme with the expense and effort involved in instituting it? Existing evidence, as recorded above, is hardly in favour of such an undertaking, especially when there are many more pressing problems which require urgent attention in the country

This does not mean, however, that the country should adopt a complacent attitude towards the problem. As unhygienic living conditions normally promote the spread of epidemic disease, it will no doubt sound paradoxical when it is stated that in the case of poliomyelitis, such conditions in themselves actually play an important role in preventing the endemic to epidemic transformation of the disease. India today is perhaps in the same position as some of the western countries were half a century or so ago. In course of time, with the anticipated improvements in environmental sanitation as a result of our successive National Five Year Plans, it is very likely that India also will witness a progressively increasing incidence of poliomyelitis as had happened in other countries. It is, therefore, necessary to take steps even now to meet that situation. It must be remembered in this connection that the process of transformation referred to above may not take as long as it did in other countries. Indeed, what has happened in isolated instances in the country would indicate that the process may have already begun.

The following lines of action are, therefore, suggested for immediate implementation. Steps should be taken from now onwards to train suitable workers in the techniques of manufacture of poliomyelitis vaccine and to set up a centre for its preparation, although on a small scale, from the locally prevalent strains of poliomyelitis viruses. These vaccines should be used well before the onset of the epidemics and evaluated from time to time for their effectiveness. The numerous gaps in our knowledge about poliomyelitis in India should be filled in the immediate future so that when the need for mass control arises, all the necessary knowledge about the epidemiology of the disease is readily available. Thus the spectrum of viruses responsible for poliomyelitis in the various parts of India and their relative importance, the group immunity picture according to age and economic status in representative places in the country, as well as the pattern of the disease and its seasonal incidence in rural and urban communities, etc. will have to be studied. The study of seasonal incidence is, indeed, of importance as the vaccination programme has to be undertaken well before the expected onset of the epidemic.

While the importance of gathering further knowledge before embarking on a vaccination programme on a country-wide basis has been stressed above, situations might arise where, it might be contended, that the use of the vaccine even now in some areas would be justifiable, as for example, in the presence of periodic severe epidemics. Protection of susceptible children in the age-group 6 months to 3 years will have to be undertaken to meet such situations.

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7. Kapila, C.C. (1948): J. Ind. Army Med. Cps., 4, 179.

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4. World Health Organisation Technical Report Series No.81. First Report of the Expert Committee on Poliomyelitis 1954.

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6. Summary Report: Evaluation of 1954 Field Trial of Poliomyelitis Vaccine, Vaccine Evaluation Centre, University of Michigan, Ann Arbor, Michigan, April 12, 1955.

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(a) Non-paralytic poliomyelitis

An illness characterized by fever, headache, vomiting, sore throat, listlessness, stiffness of neck and back; pains in the back, neck, trunk, or limbs, and hyperaesthesia; cerebrospinal fluid changes are usually found. The diagnosis is often strongly supported by epidemiological evidence; for example, known contact with a paralytic case or residence in an epidemic area.

(b) Spinal paralytic poliomyelitis

Signs and symptoms of non-paralytic poliomyelitis with the addition of partial or complete paralysis of one or more muscle groups, detected on two examinations at least 24 hours apart.

(c) Bulbar paralytic poliomyelitis

Signs and symptoms of non-paralytic poliomyelitis with involvement of the cranial nerves and/or medullary centres.

Isolation of the patient

It is established practice in some countries for patients t be isolated for 1-3 weeks from the onset of the major illness if paralytic, or from the onset of symptoms in non-paralytic cases. Periods of isolation longer than three weeks may be considered advisable under special circumstances, since excretion of virus in faeces may continue for several weeks.

When conditions permit, isolation of the patient in his home should be considered. If the patient is removed from his home, it should be to a hospital or unit for infectious diseases, a special hospital for poliomyelitis patients, or an isolation unit (one or more rooms) in a general hospital.

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Suspected cases who are removed to hospital should preferably be isolated from known cases of poliomyelitis until the diagnosis is confirmed.

At some future date, it may be possible to determine the periods of isolation for individual patients by using tissue cultures as a means of detecting the presence of virus in the faeces.

<u>Concurrent disinfection</u>. Throat discharges and faeces are infectious and should be disposed of as quickly and safely as possible. Soiled articles should be promptly disinfected by heat. Patients should have individual bed-pans unless immediate cleansing and sterilization by heat is possible.

All those attending the patient should be instructed that the disease is highly infectious and that they must pracise maximum hygienic precautions (e.g., those precautions which would normally be adopted in attending a case of typhoid fever). Hand washing before and after handling the patient is essential. Nurses need not be isolated but, where it is practicable, should not attend other patients while caring for acute poliomyelitis patients.

<u>Terminal disinfection</u>. A hospital isolation unit (or room), after being used for poliomyelitis patients, and before being opened to receive other cases, should be washed thoroughly with soap and water.

Patients should not be moved to an orthopaedic ward or hospital until the locally approved period of isolation is complete. Poliomyelitis convalescents may still be excreting virus in the stool, and therefore should not associate for 6-8 weeks from the onset of the disease with other orthopaedic patients or others in swimming-baths for rehabilitation or pleasure. If possible, poliomyelitis patients should have completely separate rehabilitation units.

<u>Measures regarding contacts</u>

<u>The family</u>. Family and intimate associates, especially children, should be considered as probably infected. Children with familial or intimate exposure should be confined to their homes for 21 days, avoiding overexertion. Adults need not be confined, but should refrain from overexertion and should observe maximum hygienic precautions; they should refrain from association with children other than their own, and should avoid intimate contact with adults. They should not handle foodstuffs served outside the family. Any associates who do not feel well should go to bed and a physician should be consult

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6. In view of the possibility that the skin may be contaminated with poliomyelitis virus, before administering an injection, cleansing with tincture of iodine is recommended, and separate heat-sterilized syringes and needles should be used for each patient.

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APPENDIX II

There is urgent need for the isolation and identification of the spectrum of poliomyelitis viruses present in various parts of the country. This work is a part of the research programme of the Polio Research Unit of the Indian Council of Medical Research situated in the Pathology Department of the Grant Medical College, Bombay. Accordingly, the Unit will undertake isolation and typing of poliomyelitis viruses from material sent from any part of the country. It is hoped that all those who deal with poliomyelitis will cooperate in this work and send material to the Unit for study. In order to help in the collection, storage and despatch of material from which poliomyelitis viruses are to be isolated to the Unit, an extract from the report of the first meeting of the W.H.O. Expert Committee on Poliomyelitis (1954), which gives precise instructions in this respect, is given below :-

[In forwarding specimens of stools, it is preferable not to use glycerol unless facilities for refrigeration are not readily available. Glycerol might interfere with the isolation of the Cocksackie group of viruses. It is requested that the specimens be accompanied by a statement showing the clinical features, results of laboratory studies, if any, and the name of physician attending on the case and of the pathologist sending the specimens. In forwarding the specimens, the regulations laid down by the post office should be strictly followed.]

A. Precautions

Isolation of poliomyelitis virus from human and other sources usually requires a team of two or more workers and their work is not without danger, since the percentage of laboratory workers who have accidentally acquired poliomyelitis in the laboratory is appreciable. For obvious reasons, therefore, sterile precautions must be taken in handling infective materials. Gowns should be worn at all times, and for certain procedures gloves, cellophane masks, and eye-shields are necessary as well. Persistent vigilance is required on the part of the director of the team engaged in this work to ensure that the individual members consistently take the necessary precautions.

B. Sources of Material

Poliomyelitis virus can be isolated by monkey inoculation and by tissue culture inoculation, from a number of materials derived from man, and from extra-human sources such as sewage and flies. However, even using the most careful technique, negative results are a common experience.

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If human material is being tested, the chances of successful isolation are greater if the material is obtained early in the disease, within the first 7-8 days, dating the onset of the disease from the first onset of fever-even though the symptoms be slight - (i.e., the "minor illness" if such occurs) and not from the onset of paralytic symptoms, which may actually occur late in the acute infection. Sometimes when it is important to obtain a strain of poliomyelitis virus quickly from a given outbreak, it is useful to visit the homes of hospitalized patients, and to determine whether any other members of the family are ill with symptoms suggesting an earlier stage of the disease. If so, they may furnish more valuable specimens than does the patient in the hospital.

1. Human autopsy material from which the virus has been frequently isolated includes:

(a) Pons, spinal cord, and medulla, provided death has occurred 7-10 days from the onset, and

(b) intestinal contents and intestinal wall.

In removing central-nervous-system tissue at autopsy, an assistant should be ready with sterile gloves and several sets of sterile instruments, or at least with the means for reboiling the same instruments frequently. Favoured sites from which virus may be isolated are the medulla, and the cervical and lumbar sections of the spinal cord; pieces about 2 cc in size should be taken from these areas and placed in a sterile Petri dish. The cauda equina is not recommended as a source of virus. At the same time, other appropriate sections of the cord should be placed in fixing solution for subsequent histological examination.

2. Clinical cases and carriers as a source of material.

Poliomyelitis virus has been isolated frequently from:

(a) Faeces;

(b) Rectal swabs (some faecal material should be obtained on the swab, if possible);

(c) pharyngeal washings (15-30 ml);

(d) throat swabs (2 from each patient).

4. Throat swabs

Material is obtained by rubbing the oropharynx vigorously with two sterile cotton swabs, which are immediately transferred to a test-tube containing 1-2 ml of sterile water or broth. The specimens should be tested promptly or kept frozen.

D. Storage of Material

Material awaiting testing or shipment may be held for short periods at refrigerator temperature (0°-4°C). For longer storage it should preferably be frozen, or it may be kept in 50% glycerol.

Freezing

Ordinary glass test-tubes containing more than 1 ml of fluid are liable to crack when frozen; therefore, if fluid material is to be frozen it should be placed in special containers, i.e., either nitro-cellulose tubes or thick-walled glass containers. Freezing may be accomplished by placing the tubes in the freezing compartment of an electrically driven regrigerator, or in a specially constructed insulated box containing soild carbon dioxide (dry ice) which may maintain a temperature of from - 20° to - 70°C. For the preservation of poliomyelitis virus, unlike certain other viruses, temperatures below - 20°C are not essential.

Glycerol

Only the purest brands of glycerol should be used for the preservation of poliomyelitis virus. The glycerol should be mixed with an equal volume of physiological saline before use.

Some points with regard to the use of glycerol are:

1. do not put more than 4 or 5 small pieces of tissue in 50 ml of glycerol-saline, and
2. do not allow the tissue to remain untested any longer than is necessary.

However, as 50% glycerol has a slow bactericidal action, it may be useful to allow bacteriologically contamined specimens to remain in it for

a few days before testing them for virus. Although poliomyelitis virus has been known to survive in 50% glycerol for many years, it has also died out in this medium after a few months or even weeks.

Lyophilization

As a method of preserving poliomyelitis virus lyophilization has been accomplished with various diluents such as 10% monkey serum, and mucin. However, results are irregular and lyophilization is not recommended for this purpose.

E. *Shipping of Specimens*

If frozen material is to be shipped short distances, it should be sent in a proper container, such as an insulated box containing dry ice, or a well-packed thermos flask containing dry ice. Special care in packing thermos bottles is essential or breakage may easily occur.

The necessity of keeping all specimens cool probably varies with circumstances.

A more practical method for shipping involves the use of 50% glyce[illegible] Autopsy specimens, stool specimens (small in amount), and the sediment from rectal swabs, pharyngeal washings, and throat swabs may all be sent at room temperature in 50% glycerol. For this purpose it is convenient to use small wide-mouthed bottles with tightly stoppered or capped orifices, and, for safety, the top of each bottle should be wrapped with several layers of water-proof tape. Before preparing such material for [illegible] the fragments of tissue or particulate matter should be washed several [illegible] in saline solution to remove some of the glycerol.